Engineering Library
SEP 27 1917
UNIV. OF MICH. LIBRARY

No. 7. Vol. X. July, 1917.

The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by

LEON GASTER

10/6 Yearly.

THE JOURNAL OF SCIENTIFIC ILLUMINATION.

1/- a Copy.

OFFICIAL ORGAN OF THE

Illuminating Engineering Society.

(Founded in London 1909.)

This number contains some ***Notes on Industrial Lighting,*** based on a recent series of articles by Mr. C. E. Clewell, and the ***Standard Specification for Glow Lamps,*** framed by the Swiss Union of Electricity Works, which deals both with vacuum and gas-filled electric metal filament lamps.

Other matters dealt with include:

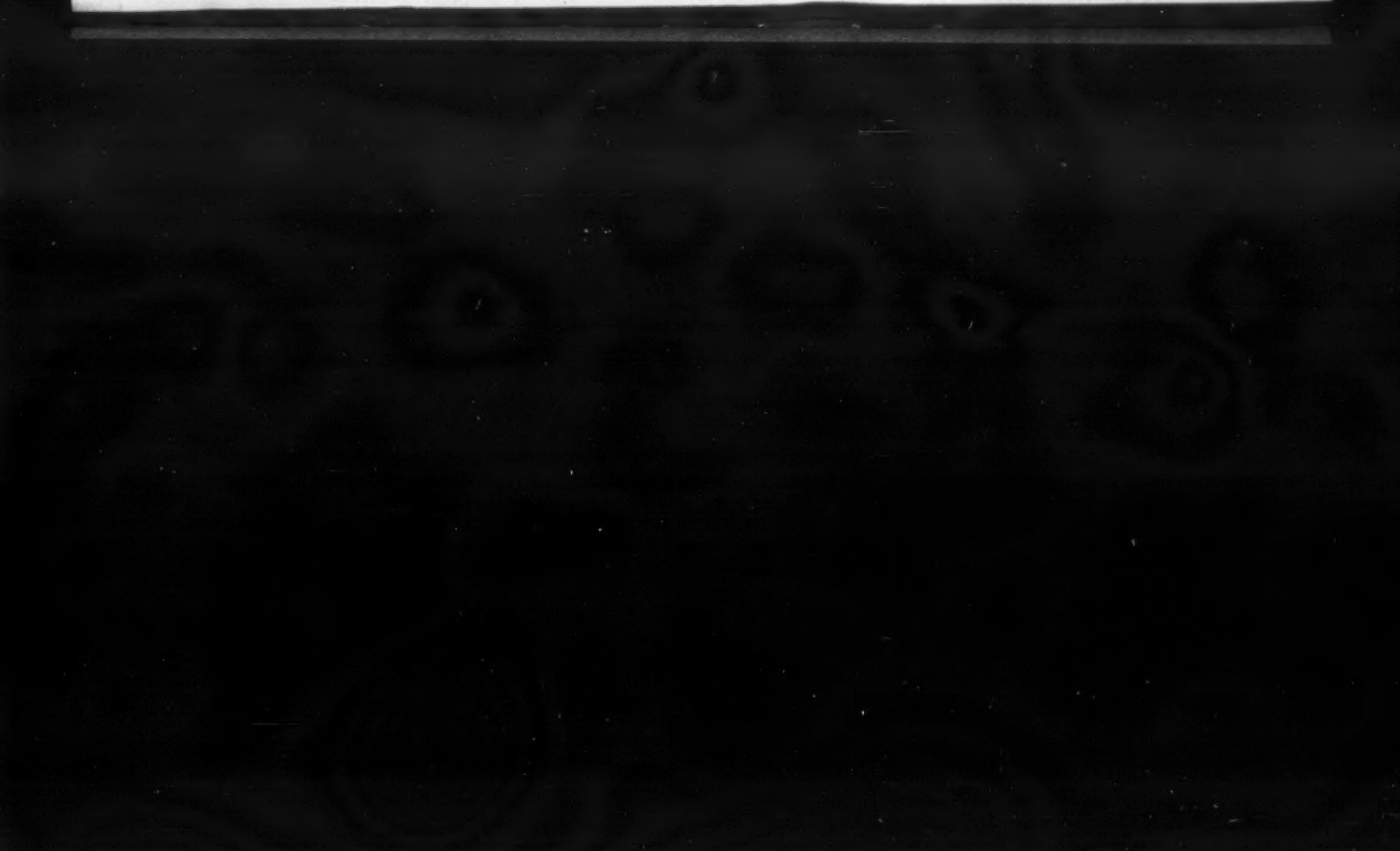
AUTOMOBILE HEADLIGHTS—THE USE OF NEUTRAL GLASS IN PHOTOMETRY—A NATIONAL COMMITTEE ON LIGHTING IN THE UNITED STATES—RADIATION FROM HELICAL FILAMENTS—THE PRODUCTION OF GAS IN THE UNITED STATES, etc.

ILLUMINATING ENGINEERING PUBLISHING COMPANY, LTD.
32, VICTORIA STREET, LONDON, S.W.
(TEL. NO. VICTORIA 5215.

THE GAS LIGHT AND COKE COMPANY

will be happy at any time to co-operate fully with any Member of the Illuminating Engineering Society in the planning of the lighting of any room or building situated within their area of supply, and in making any experiments in connection therewith to the end of ensuring its illumination on scientific and practical lines.

Communications addressed to the Chief Office, Horseferry Road, Westminster, S.W., and mentioning "*The Illuminating Engineer*," will receive special attention.



The
ELECTRICITY · ACETYLENE ·
ILLUMINATING ENGINEER
OIL · GAS
Edited by
LEON GASTER

THE JOURNAL OF SCIENTIFIC
ILLUMINATION.
OFFICIAL ORGAN OF THE
Illuminating Engineering Society.
(Founded in London, 1909.)
ILLUMINATING ENGINEERING PUBLISHING COMPANY, LTD
32, VICTORIA STREET, LONDON, S.W.
Tel. No. 5215 Victoria.

EDITORIAL.

Progress in Industrial Lighting.

On pp. 185—189 in this issue we give a summary of some of the chief features in a series of articles on Industrial Lighting by Mr. C. E. Clewell, which have been appearing in the *Electrical World*.

Progress in industrial lighting during recent years has been very rapid. A feature has been the development of overhead general lighting, and Mr. Clewell suggests the application of this method to foundries and other workshops where it has not hitherto been generally employed.

The chief need, in order to bring home the benefits of up-to-date factory lighting, is the provision of concrete evidence of its influence on output and in diminishing accidents. Mr. Clewell mentions the case of a works which, after spending 50,000 dollars on improved lighting, caused an enquiry to be made into the nature of the ensuing benefits. A number of instances of waste and lost time, directly due to the old and imperfect lighting, were

revealed. Many of them, probably, would not have been revealed but for the change to the new conditions.

Equally useful are the diagrams presented, which we reproduce on p. 187, showing actual cases of accidents traced to defective lighting conditions. Such illustrations are most useful for propaganda work. It would be most instructive if the freedom from accidents, the improvement in output, and the diminution of spoiled work following improved illumination could be computed in terms of cash, in the form of a return on the lighting as an investment. If this could be done in particular factories the results would, we believe, prove a revelation to many manufacturers. Expenditure on lighting has been shown by many investigators and is known to be almost invariably a small fraction—sometimes less than 1 per cent. of the wages bill. Mr. Clewell, dealing with the special case of motor-car shops, also calculates that the cost of installing proper lighting forms only about 3% of the total cost of equipping a shop of given area, and in many cases we imagine it would be even less. Such figures show the wisdom of judicious expenditure on illumination.

Perhaps the most interesting section of the series of articles is the comparison of the chief " codes " and reports relating to lighting in factories. Such codes were introduced last year into the legislation of two States, Philadelphia and New Jersey, while the regulations in force in Wisconsin, which date from 1913, are now undergoing revision. The chief respect in which these codes differ from the Report of the British Home Office Committee is the inclusion of the minimum illumination desirable for various classes of work. These values, in the light of present knowledge, must be looked upon as tentative, but it is interesting to observe that, according to investigations carried out in up-to-date factories, they are well within the illumination actually provided. It is only those factories which are distinctly backward in regard to illumination which fail to come up to the required standard.

Mr. Clewell, like authorities in this country, recognises the desirability of proceeding cautiously in enforcing the provision of standards of illumination by legislation. Admittedly there are difficulties, which time will overcome, in enforcing a standard based on the provision of a certain illumination in foot-candles. But it is shown very clearly that methods based on " watts per square foot " or " candlepower per square foot " are open to grave objection on principle, and it is significant that in the State of Wisconsin the former method, which was used in the pioneering code of 1913, is likely to be replaced by values on an illumination basis.

This series of articles is timely in view of the recent recognition by the United States Government of the importance of proper methods of lighting in war time. On p. 197 we refer to a most important step, the appointment of a National Committtee on Lighting, on which the Illuminating Engineering Society in the United States, with the co-operation of the gas and electric lighting interests, is to co-operate with the Council of National Defence. The Committee is to advise on all matters relating to lighting, especially in regard to factories, mills, arsenals, munitions plants and concerns under contract to the Government, and will prepare specifications and rules relating thereto. The United States Government has acted with commendable enterprise and promptness in this matter and we feel sure that their wise decision to make full use of experts on lighting will have most valuable results.

A New Epoch in National Education.

The recent address by Mr. Fisher in the House summarising his proposals for the extension of school years marks a new epoch in national education. It is suggested that child labour under the age of 12 should be prohibited from the date of the passing of the Bill, that there should be full elementary education up to the age of 14, and that half-time and exemptions are to be abolished as from the end of the war. Continuation schools are to be made compulsory up to the age of 18 for all who have not received full time education up to 16, and continuation scholars will receive instruction for not less than 8 hours per week, part of which will be devoted to physical training. An important point is that these hours are to be set aside from the normal period of employment.

These suggestions mark a very distinct advance. The proposals will no doubt undergo some modification before the final Bill is passed, but it is to be hoped that these very moderate demands will meet with approval. Indeed many people would consider that the time allotted for continuation classes, at a time when continuance of education is specially beneficial, is hardly sufficient. A period of 8 hours a week, including physical training, does not leave much time for intellectual training. We assume, however, that Mr. Fisher has found it necessary to proceed with caution, and in the present circumstances it will be very satisfactory if the advance he foreshadows is carried into effect.

We shall return shortly to the industrial aspects of these proposed educational changes; but we would like first to emphasise the point that, apart from its material value, continuity of education is necessary also in order to produce good citizens. Everyone who has studied social problems and labour difficulties must have felt that in many cases trouble is due to inability to make sound judgments and take a wide outlook. An educated democracy is less liable to be swept away by short-sighted ideals and misguided ideas. In a more enlightened age such conflicts as that in which the greater part of the world is now engaged would be less likely to occur and might even be rendered impossible.

Finally we should like to point out that not the least valuable result of education is that it leads to a fuller enjoyment of life and a better use of leisure. A man or woman who has intellectual resources outside the daily task gets far more out of life than one whose mind is uncultivated and whose interests are narrow and few. Many of the social evils of to-day are due largely to the absence of these wider interests and the want of congenial recreation.

In the debate in the House some reference was made to the presumed hardship of parents being obliged to keep their children at school when their contributions as wage-earners are needed for the upkeep of the home. Much perseverance will be needed to dispel these ideas. The desired results must be attained without imposing undue hardship on parents who may not be prepared to meet this additional burden out of their present limited income. We believe it could be shown that more generous educational facilities would ultimately enable the children to make better provision for the support of the home and that parents who have the welfare of their children at heart would not, for the sake of immediate pecuniary gain, stand in the way of their advancement.

National Education, its Industrial Aspects.

Having dealt with the more general aspects of the reforms in education proposed by Mr. Fisher, we desire to say something on their industrial aspect. There has been much discussion recently on the relative claims of the humanitarian and industrial aspects of education, and it is fortunate that we have in Mr. Fisher a Minister of Education in a particularly good position to do justice to both these conceptions of training. As Vice-Chancellor of Sheffield University he has been brought in very intimate touch with technical education in relation to industry, yet his own broad interests and his association with such work as that of the Workers' Educational Association enables him to take the necessary wide views.

From the industrial aspect the proposed changes are of momentous importance. We have always felt that the gap existing after children have left the elementary school is one of the chief defects in the educational system of this country. This break in continuity means that early educational influences are largely wasted, that mental development is checked and that children thus tend to become mere cogs in the industrial machine. Thus while we have generals and captains of industry we lack the material for intelligent subordinate officers. The establishment of compulsory continuation schools should help to bridge this gap. Equally important will be the steps foreshadowed in the Interim Report of the Consultative Committee on Scholarships for Higher Education issued in July last year, providing for the establishment of bursaries and scholarships, not only giving free higher education for gifted children, but a contribution to their living expenses during the period of study.

Such steps would help towards removing the great obstacle to higher training of children in the poorer classes—the disinclination of parents to lose such contributions which they might be making as wage-earners to the upkeep of the home. It is equally important that both manufacturers and the State, recognising the far greater value of educated workers, should do everything possible to encourage education. Parents and children should be convinced that better education, so far from being a pecuniary drawback, will enable them to earn wages and assume positions which would otherwise be outside their scope ; and that continuation of instruction is an investment which will give a good return.

A great deal is being said of the advantage to the manufacturers and the nation of securing better educated workers. We are glad that this view is gaining ground for we are convinced that the prosperity of this country involves the provision of better education and a more lively appreciation of its benefits. Whatever the outcome of the present conflict, the future of nations depends primarily on the knowledge, skill and intellectual value of their people.

But at the same time the workers should be made to feel that educational facilities are not merely a dodge on the part of manufacturers to get more out of them. The process acts both ways. It enables manufacturers to achieve greater results and make better profits. But it entitles the educated worker to a higher wage, enables him to rise to higher positions, and adds immensely to the possibilities of life. Above all it will enable him to gain a better insight into industrial and social conditions and to bring about juster and more cordial relations between capital and labour.

LEON GASTER.

AUTOMOBILE HEADLIGHTS.

The *Transactions of the Illuminating Engineering Society* (U.S.A.)* contains a series of three papers by W. F. Little, S. C. Rogers, and E. J. Edwards, on the design of headlights and the framing of regulations relating thereto.

Mr. Little illustrates in detail a considerable number of typical lens and mirror arrangements, many of them specifically designed to minimise glare. The problem involves a compromise between satisfying the latter condition and the provision of sufficient illumination for the motorist to find his way with safety and comfort. A number of misconceptions are mentioned—such as that the lenses and mirrors *increase light*, whereas they only redistribute it. Many of the devices suggested for diminishing glare (*e.g.*, the use of rheostats, translucent diffusing screens, etc.) only do so by diminishing the light as a whole and thus weakening the illumination. They may be of service in special cases where the need for eliminating glare is accompanied by a smaller demand for road-illumination; but generally speaking the diminution of glare should be accomplished by altering the distribution of the light rather than diminishing it. The adoption of special lens surfaces, and the device of making the mirror in two sections of different foci, seem preferable in this respect.

A circular on the subject was addressed to twenty-eight men who were understood to have given the subject special consideration. The majority favoured the restriction of the main beam below the horizontal, but it was recognised that some oblique illumination of the sides of the road and of surrounding objects is also needed. As a rule the beam from a headlight need not illuminate the road for more than 300 feet ahead; it is suggested that the width of road illuminated sideways should be about one-tenth of the length of road illuminated ahead. Some observers consider that a yellow beam is less glaring, for a given intensity, than a white one.

Mr. S. C. ROGERS refers to the regulations of a number of States bearing on headlights, and these are also discussed by Mr. Evans. In most cases the regulations contain general phrases such as that the light should not be of a dazzling character, which are open to very varied interpretation. The framing of precise regulations is a matter of considerable difficulty. The apparent efficiency of a headlight will depend on the nature of the road surface, *i.e.*, whether of light or dark material and, owing to the oblique illumination, glare is apt to be produced by direct reflection from a polished surface.

A difficulty in following the prescription regarding the limitation of rays to below the horizontal is that such a condition would not operate satisfactorily on roads of rapidly varying declivity and having marked irregularities in their surface.

Headlamps in use commonly give, with a parabolic mirror, from 10,000—100,000 maximum candle-power. The selection of a filament of small superficial area is essential to produce a relatively narrow beam and avoid objectionable images, and it is also desirable that the position of the filament should be capable of exact adjustment at the focus of the reflector.

No. 3, Vol. XII., April 30th, 1917.

THE NATIONAL PHYSICAL LABORATORY.

The Annual Meeting of the General Board of the National Physical Laboratory was held at the Laboratory on May 19th. The President of the Royal Society, Sir J. J. Thomson, is Chairman of the Board; Lord Rayleigh is Chairman of the Executive Committee.

The outstanding feature of the year has been the growth of the gauge-testing work. Nearly the whole of the gauges required for the inspection of munitions are now examined at the N.P.L., the number averaging about 10,000 weekly. By arrangement with the Minister of Munitions a new building has recently been erected to accommodate the work, the space otherwise available having become quite insufficient for the purpose. There has been a great increase also in the number of optical and electrical instruments tested for the Admiralty; a new branch of work is the testing of luminous dials for instruments of various kinds.

The investigations carried out have been, in the main, of confidential character Aeronautics research has continued to be of great importance. The William Froude National Tank has carried out much work for the Admiralty, and has been visited by members of the Board of Admiralty—including Mr. Balfour when First Lord—who have expressed much appreciation of the results attained. In the Metallurgy Department researches on light alloys, and on optical glass, have been continued, while a number of special problems have been dealt with. Various investigations have been in progress in the Engineering Department: hardness tests, methods of impact-testing, the fatigue resistance of materials under combined bending and twisting stresses, the transmission of heat from surfaces to fluids flowing over them—as in the flow of air over an aeroplane engine—are among the questions examined. The observations on the rate of growth of cracks in the buildings of the Tower of London have been continued. No serious disturbances have been detected.

Much attention has been given recently to the question of the future of the Laboratory, and in particular to its relations with the Department of Scientific and Industrial Research, and a scheme will no doubt be arranged whereby close relations with the Department will be established.

CONJOINT BOARD OF SCIENTIFIC SOCIETIES.

The fourth meeting of the Conjoint Board of Scientific Societies was held at the Royal Society on June 13th, Sir Joseph J. Thomson, O.M., Pres. R.S., in the chair, to receive the report of the Executive Committee on the work of the previous six months.

A number of important questions of scientific and industrial importance has occupied the attention of the Board.

Interim reports were received and approved on the necessity for an anthropological survey of the British people, on the best methods for carrying on the International Catalogue of Scientific Literature, and on an enquiry into the desirability or otherwise of the adoption of the metric system throughout the British Isles.

The Sub-Committee on National Instruction in Technical Optics reported that a scheme approved by the Board of Education had now come into operation. Under the ægis of the Imperial College of Science and Technology an Advisory and Administrative Committee had been formed to organise instruction, and Mr. F. J. Cheshire, a member of the Sub-Committee of the Board, has been appointed Director of Studies in Technical Optics.

Among other matters being considered are: The publication of information being collected on the mineral resources of the Empire, magnetic disturbances throughout the British Isles and their possible connection with the presence of iron ores; the fransport of raw materials to farms and agricultural products from them, and the respective advantages of steam, internal combustion, and electrically operated machines in this connection; the amount and distribution of water power in the British Empire.

A complete report of the first year's work of the Board will be published in due course.

SCIENTIFIC RESEARCH IN FRANCE.

The *Académie des Sciences* has decided to establish a National Research Laborator nn France The laboratory is to be controlled by a Council, half of the members be to nominated by the *Académie*, one fourth by the State Department and the remainder by the chief industrial associations. Existng laboratories will be affiliated with the National Laboratories will and work in cooperation with it.

NOTES ON INDUSTRIAL LIGHTING.*

By C. E. CLEWELL.

Two important considerations in favour of proper industrial lighting are (1) The effect on the eyes and health of workers, and (2) The effect on the efficiency of factory management.

While it is agreed that inadequate lighting must handicap eyesight, it is not so generally recognised that the eye being in a sense the "weakest link in the chain" is particularly easily injured by strain. With advancing age the eye is one of the first organs to be affected, and exceptional fatigue, while lowering the tone of the whole body, is very apt to prejudice vision.

The fact that good lighting is conducive to improved output and better quality of work is recognised, but as yet we have not a great mass of data based on actual cases of saving due to good illumination.

How Good Lighting Saves Time.

Such a case is mentioned by the author. A firm recently expended 50,000 dollars in bringing its lighting thoroughly up to date. An inquiry was afterwards instituted and a number of instances of directly beneficial results were brought to light. For example: (a) A manager in one department stated that before the improvement was introduced it was difficult to induce the best type of man to stay; after the improved lighting was introduced there was no such difficulty. (b) A man who under the old conditions was in the habit of spending time looking for material and moving from place to place in the shop, found a great saving in this respect with the improved illumination. Presumably he could see better where things were kept, and it was also noticed that he kept the floor tidier and free from scrap. (c) A foreman stated that before the good lighting was introduced it had been found that men on the night shift would not work for the last three hours, complaining that the lights were out of order. Difficulty was also experienced in getting men to start work on dark mornings, and as much as two hours was sometimes wasted in this way. (d) It was noticed that one of the workmen often found it necessary, when making a measurement, to put his thumb on a place on the rule and then walk away to a spot under the light to read the figure. With improved lighting there was no need for him to leave his place.

Obviously all such difficulties as those referred to above have a cumulative effect in causing loss of time. Dealing with a case in which the running cost of lighting per bay worked out to 17 cents per day, Mr. Clewell calculates that it would only be necessary for a workman to save two minutes in a day of eight hours to meet the lighting cost. This is very close to calculations made by other observers. In another case where specially skilled work is involved, in motor-car work, Mr. Clewell estimates that the running cost of lighting amounts to only one-tenth per cent. of the wages bill.

Illumination as a Return on Investment.

It would, Mr. Clewell suggests, be very helpful if the advantages of improved lighting could be presented in the form of a return on investment. No doubt the return would depend to a great extent on the nature of the work and the local conditions, and at present there are few cases in which a sufficiently careful check has been made to enable such a return to be made. Experiments in certain works are now being conducted with this end in view.

* Based on a series of articles appearing in the *Electrical World*, June 2nd, 9th, 16th, 23rd, 30th; July 7th, 14th, 1917.

Illumination Data for Industrial Lighting.

Mr. Clewell gives figures for gas-filled lamps and ordinary vacuum lamps approximately as follows :—

Gas-filled lamps, 9—10 lumens per watt.
Vacuum lamps, 11·5—18 lumens per watt.

He emphasises the great importance of choice of shades, and traces the steps in industrial lighting development during recent years. There is a strong tendency towards general overhead lighting. With the high candlepower lamps available this is quite practicable and has two great advantages : (1) That the lamps can be kept high up out of view leaving the room clear, and (2) That the lighting system is independent of the positions of benches, etc.

For many classes of such work one would secure good conditions by assuming the use of 100-watt vacuum lamps operating at 10 lumens per watt, and used in such a way as to give a utilisation efficiency of 40 per cent. Then with 1 watt per square foot, and 0·8 mean spherical candlepower per square foot, or ten generated lumens per square foot, one should get a uniform bench illumination of about 4 ft.-candles. Reference to the above figures for the efficiency of vacuum and gas-filled lamps suggests that with the latter illuminant one might expect, for the same consumption, an illumination 50 to 100 per cent. higher. Similar figures could readily be worked for overhead gas lighting.

Foundries and Machine Shops.

Dealing with foundry and machine shops, Mr. Clewell emphasises the importance of the daylight factor, *i.e.*, the percentage of the unrestricted outside daylight illumination that finds its way into the shop at the place where work is done. This factor is commonly within 0·5—2 per cent., but in cases where there is reliance mainly on lateral lighting, and the interior surroundings are dark, one may find figures as low as 0·1 per cent. or even 0·01 per cent. Assuming, however, that 0·1 per cent. is realised it can be calculated that on an average December day the minimum daylight illumination will not exceed 0·75 foot-candle. At this season of the year, therefore, the provision of artificial illumination is indispensable, even throughout the day-shift, on many kinds of work.

In view of the fact that workers in foundries are constantly moving about, and that the floor is often uneven or littered with material, general overhead lighting is considered very desirable. As, however, vertical surfaces have so often to be dealt with strong side-lighting is also useful, and this may be secured by adopting reflectors with a "spreading" distribution of light.

With gas-filled lamps 0·25 watt per square-foot is a usual allowance.

The following values are suggested for foundry and shop work :—

TABLE I.

	Foot-candles.
Forge and Blacksmithing :—	
Ordinary anvil work	2— 4
Machine forging	2— 3
Tempering	2— 4
Tool forging	3— 5
Foundry.	
Bench moulding	1— 3
Floor moulding	1— 2
Machine Shops.	
Assembling	4— 7
Drills	2— 4
Millers	3— 6
Planers	3— 5
Rough manufacturing	1·25— 3
Fine manufacturing	3·5— 6
Special fine work	10—15
Stock Room.	
Rough materials	1— 3
Fine materials	2— 4
Ordinary storage	0·25— 5

Motor-Car Shops.

Another case of industrial lighting discussed is the illumination of motor-car shops. The output of cars in the United States has risen from one million in 1909 to sixteen millions in 1916, and the estimated value of goods from 250 to 5,000 millions. The opportunity for proper lighting in this industry is therefore evident. It is stated that the lighting equipment of a modern factory is of the order of 50—150 dollars per 1,000 square feet. The lower figure is estimated to be only 3 per cent. of the total cost of equipment and erection. There should therefore be no grudging of the expense of proper illumination in planning a factory.

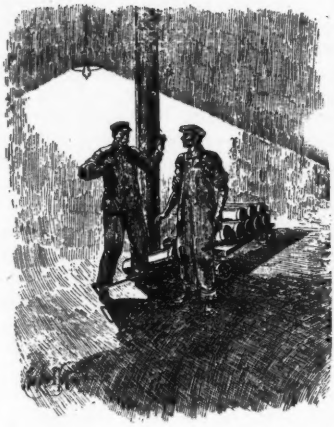


FIG. 1.—The workman pulling the truck failed to see an iron bar near the floor, which caused the truck to swerve to the right. In so doing it dislodged the truck handle from the man's grip and caused a heavy pipe to fall from the truck on another worker's leg, breaking it below the knee. Owing to the dense shadow cast by the pillar it was practically impossible to see the iron bar which caused the trouble.

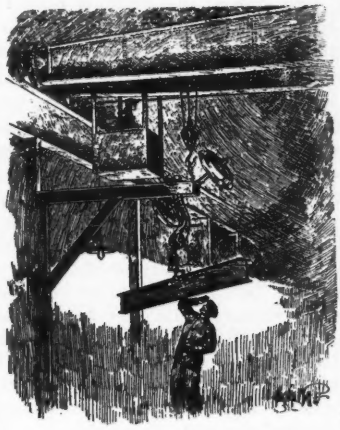


FIG. 3.—The post crane was struck by the load suspended from a travelling overhead crane and the shock displaced a steel beam, which fell and caused injuries to operators below. This shows the drawback of using only lights with opaque reflectors placed at a low level below the post crane projection, which received no light and was invisible from above.

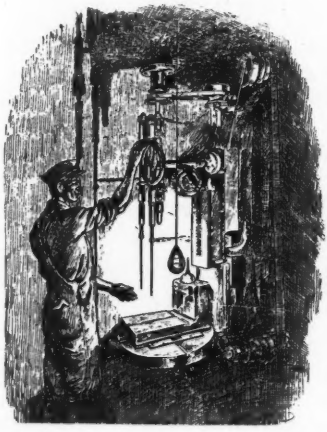


FIG. 2.—Blinded by the glare from the bare lamp over the drill-press table, the operator allowed his fingers to get within gears while reaching for the drill-press feed control.

FIG. 4.—Owing to inadequate lighting the man carrying the bar failed to see the man in front of him and the latter was struck in the back of the head by the projecting iron bar.

Examples of how Inadequate Lighting Causes Accidents.

(C. E. Clewell, *Elec. World*, June 16th, 1917.)

In two typical installations described the consumption with gas-filled lamps is about 1 watt per square foot.

Illumination and Safety.

Dealing with the question of safety, Mr. Clewell emphasises many of the points recently commented upon in this journal. He quotes the views of a large insurance company in the States to the effect that 23·8 of 91,000 accidents investigated might be traced directly or indirectly to inadequate lighting. It is to be noted that the Pennsylvania and New Jersey factory lighting codes both require auxiliary lighting, which is to be thoroughly dependable at all times. Some instructive cases of actual accidents due to defective lighting are described. We reproduce on p. 187 the diagrams relating thereto.

Legislation Requirements on Factory Lighting.

An interesting review is given of legal requirements in respect of factory lighting, reference being made both to the Report of the British Departmental Committee on Lighting in Factories and Workshops, the code drawn up by the Illuminating Engineering Society in the States, and the codes introduced by the States of New Jersey and Pennsylvania.

Mr. Clewell agrees with the views expressed in the British Report that the legislative requirements can easily be met without hardship by modern factories, and are intended merely to bring up to standard the more backward works.

Some charts are reproduced comparing the illumination actually found in typical American factories with the legislative values. In well-equipped factories the illumination provided is shown to be well above that desired for fine manufacturing (3 foot-candles), and far above that for rough manufacturing (1·25 foot-candles). On the other hand backward cases are also collected where values ranging from 0·5 to 1 foot-candle are recorded, and these values, while sufficient to meet the requirements of the British Report from the standpoint of the minimum general illumination for safety and convenience, are insufficient for the carrying on of many of the processes, *e.g.*, in machine shops. These figures are, however, striking in showing the very reasonable requirements of the British Report.

In Table II. are collected the requirements as regards illumination of various codes. Here the fundamental difference between the requirements of the American codes for carrying on work, and the values suggested in the British Report, which refer merely to safety and convenience, should be borne in mind.

TABLE II.

ILLUMINATION REQUIREMENTS IN FOOT-CANDLES IN VARIOUS CODES AND BY DIFFERENT AUTHORITIES.

Class of work.	Clewell's "Factory Lighting," 1913.	G.E.C.'s "Handbook on Lighting," 1913.	Wisconsin "Orders," *Minimum*, 1913.*	Ill. Eng. Soc. (U.S.A.) "Code of Lighting," *Minimum*, 1915.	Report of British Departmental Committee on Lighting in Factories and Workshops, *Minimum*, 1915.†	Pennsylvania Code, 1916.		New Jersey Code, 1916.	
						Min.	Good practice.	Min.	Good practice.
General lighting	—	0·08	—	—	0·25	—	—	—	—
Yards, roadways, &c.	—	—	—	—	0·05	0·05	0·05—0·25	0·05	0·05—0·25
Stairways, etc. ..	0·5	0·5	—	0·25	0·1	0·25	0·25—0·5	0·25	0·25—0·5
Foundries ..	—	3	1·5	1·25	0·4	1·25	1·25—2·5	1·25	1·25—2·5
Rough manufacture	3	2	0·75	1·25	—	1·25	1·25—2·5	1·25	1·25—2·5
Fine manufacture	5	5	1·5	3·5	—	3·5	3·5 —6	3·5	3·5 —6
Extra fine manufacture ..	—	—	—	—	—	5	10—15	5	10—15

* The values in this column have been estimated from the specifications of candlepower per square foot as listed in the original code (now being revised).

† The values given in this Report were intended only to cover the amount of illumination necessary in the interests of safety and convenience. Additional illumination for the purpose of carrying on the work would be required, but these values have not yet been specified.

Dealing with the problem of enforcement Mr. Clewell recognises the difficulties involved in prescribing a standard of illumination on the working area, which would require to be checked with illumination photometers. These, however, can be met in course of time. Other methods of dealing with the amount of light provided, *e.g.*, in terms of watts per square foot or candlepower per square foot (which figures in the Wisconsin shop-lighting orders, issued in 1913 but now undergoing revision) are quite unsatisfactory. For the former takes no account of the different efficiency of illuminants, and even the latter ignores the very important influence of the location of the lights and type of reflector employed.

The mere statement of illumination by itself, however, only covers a part of the problem and requires to be considered in conjunction with recommendations on other important points such as the avoidance of glare.

THEATRE LIGHTS OF THE PAST.

Under this title the *Edison Monthly* prints some interesting notes on the beginnings of stage lighting.

For three centuries, from 1500—1800, the stage was lighted by candles and oil lamps set in rows across the front of the platform, while the most elaborate effect produced was to place a light on the end of a pole, which the audience were expected to recognise as the moon.

Then for eighty years, from 1800—1890 there came a new era with gas as the illuminant. The lighting effects were considered miraculous in comparison with those of the pre-gas days. Yet the difficulties in some of these early displays were quite formidable. The Academy of Music in New York is stated to have been one of the first theatres to use gas. Every night, long before the doors were opened, the three gas men who constituted the regular house staff began their work. First came the huge chandelier, made up of more than a ton of iron and glass and carrying four hundred burners, all of which had to be lighted by hand. Stage lights took up almost as much space as the scenery itself. Long yards of rubber pipe trailed across the wings. By an ingenious system of pulleys a light placed behind a yellow disc simulating the rising sun was made to ascend in the heavens, dragging its gas tube unseen behind it. If the pulleys creaked and the light wobbled it was still a mighty fine moon compared with the light on a stick that it replaced.

Electric lighting is generally believed to have been first introduced at the Lyceum Theatre by Henry Irving, an enthusiast for lighting effects. It was introduced at the Bijou Theatre, Boston, in 1882, where a small Edison plant was installed. From that time onwards the tendency has been towards more and more elaborate effects. Quite recently, however, there has been a revulsion towards more simple lighting. The Irish Players in a piece known as "The Rising of the Moon" struck a new note by simply playing a strong yellow illumination from one side, giving sharp relief effects.

To-day it is recognised that lighting is a most valuable tool, capable of adaptation within wide limits according to the nature of the performance.

In modern theatrical performances the appeal to the eye is quite as important as the spoken words, and during recent years illumination has played an ever-increasing part in performances on the stage.

NEUTRAL GLASSES AND OTHER METHODS OF DIMINISHING INCIDENT LIGHT IN ILLUMINATION PHOTOMETRY.

BY AN ENGINEERING CORRESPONDENT.

There is one problem that everyone interested in the design of photometric instruments has met—the difficulty of bringing about diminution of transmitted light according to a prescribed law.

The problem requires a little explanation. In almost every photometric instrument the adjustment of the photometric balance is made by adjusting the illumination from the small electric lamp within the photometer. This adjustment of illumination may be made in several ways, by altering the distance of the lamp, the angle of inclination of the light on the photometric surface, or the current through the lamp; or by making use of a diffusing screen, the area of which can be masked in varying degree by a suitable shutter. All these methods are used in well-known illumination-photometers.

Only rarely is there any attempt to adjust the photometric balance by altering the intensity of the transmitted light, *i.e.*, the light entering the photometer from the lamp or surface being examined. There are practically only two instances of this, the use of neutral absorbing glasses and the special tube-contrivance employed by Trotter and Waldram in making daylight measurements. In view of the very high illumination to be measured in the case of daylight some such device is obviously necessary. The Trotter-Waldram tube-device utilises a known portion of a presumably evenly bright white sky, but this method, while convenient for certain daylight problems, has obvious limitations.

The most usual device to extend the range of illumination photometers is to use dark glasses of known transmission and presumed neutral qualities to absorb a prescribed percentage of the incident light. For example, such glasses may transmit 10 or 1 per cent. of the light, enabling the scale of the instrument to be multiplied by 10 or 100.

It will be observed that in both cases all that is attempted is to introduce a convenient multiplying constant to extend the scale. It is not sought to diminish the incident light according to a definite law, and to indicate this progressive diminution on a suitable scale.

On the other hand, in early attempts to make photometers of the "extinction" class this was suggested. If we are ever successful in finding some suitable basis for illumination-photometers other than the glow-lamp and battery—if, for example, we were able to obtain a judgment by noting the illumination at which fine detail or colour just fails to be perceived—we should have to rely on diminution of the incident light, as there would be no illumination from within the instrument to adjust.

The most obvious way of producing this diminution is to use a wedge of neutral glass which can be gradually moved across the field of view, giving a progressively increasing absorption of light, as the thickness of the glass increases. The method has the objection that unless the tapering of the wedge is very gradual the two sides of the field will be unequally illuminated; also that it is difficult to obtain wedges uniform in dimensions and absorbing power, free from striations or bubbles, and of true neutral composition.

In any case they are expensive to make—in present circumstances they would be practically unobtainable. A somewhat simpler method, suggested by Mr. J. M. Trezise,* and applicable to

* *Illum. Eng.*, March 1916.

small fields, is to allow the light to pass through a plate of neutral glass, which can be tilted to receive the light at various angles. In this way the thickness of glass is progressively increased, and the amount of light lost by reflection from the surface of the glass will also become greater. The illumination could thus be varied considerably, and the alteration indicated on a scale by calibration. The law is empirical, and the scale would only be open over a certain range.

Neither of these methods would give rise to a straight line law, and at present there is always the doubt whether any absorbing glass is really neutral if used in sufficient thickness to transmit only a relatively small amount of light. According to a recent paper by H. P. Gage*, so-called neutral glass is at present made by the combination of two complimentary absorptions such as yellow and blue, and there are commonly bands in the spectrum. To obtain a perfectly neutral glass with a smooth spectrum would require a considerable amount of research, but it would be a great advantage if the composition of such a glass could be definitely determined. The best neutral glasses at present available answer, with fair accuracy, for white light, but it would probably be injudicious to rely on them too closely in studying coloured light.

It has been suggested that one might substitute for neutral glasses special screens, made up of a fine network of wires, or fine lines ruled on a transparent surface so as to allow a definite percentage of light to pass. It might then be possible to diminish the light by altering the angle of inclination of such screens, or adjusting the relative positions of two lying one upon the other.

There are possibilities in this direction and the method has at least the apparent advantage of eliminating the colour-difficulty. But it is not enough merely to rule opaque lines at equal intervals. This would only give 50 per cent. absorption. In order to get an absorption of 90 or 99 per cent. it would be necessary for the screen either to consist of fine clear lines at intervals with an appropriate black space between them, or clear dots on a black ground.

If the screen were being used close to an evenly bright surface, such as an illuminated opal glass, one could no doubt easily produce the required absorption in this way. But if it is to be used irrespective of the dimensions of the light source or in an illumination photometer of the Lumeter type in which observations are made of a distant object with the absorbing screen relatively close to the eye, the lines would have to be extremely thin, and the dots extremely small, otherwise the effect would not be that of a neutral glass, and the eye would merely observe isolated bright points. Indeed, if one considers a 99 per cent. absorption glass, in which the ratio of dark area to bright area is 99 : 1, it seems rather questionable whether the clear dots would not appear as individual bright specks, even if of microscopical dimensions.

The experimental difficulties are also not inconsiderable. The easiest method to produce such a screen would perhaps be to photograph down from a large diagram, but this introduces the question of the permanence, as regards absorbing power, of the clear portions of the gelatine. A more accurate method would be to scratch lines on glass coated with a thin black surface with a dividing machine; even here, to ensure strict accuracy, allowance would have to be made for the absorption of the clear glass, and the surface of the screen would have to be protected with a cover glass, which would again introduce some absorption and would have to be kept scrupulously clean.

Among other "dimming" devices that have been tried is the method of crossed Nicols. This is employed in some spectrophotometers. But this method is open to the objection that one cannot see the outlines of an observed object clearly through such an arrangement. It would therefore not be convenient for "brightness-photometers," and in any case, unless very large and expensive Nicols were used, the distance of the observed source from the Nicols would probably have to be kept constant during tests in order to avoid possible

* *Trans. Illum. Eng. Soc.*, U.S.A., 1916.

errors due to variation in the amount of light lost in transmission.

A more hopeful plan would perhaps be to produce the polarisation effect by double reflection from two inclined pieces of black glass. The image could then be distinguished, but the transmission would always be a long way below 100%. Polarisation methods, like the neutral glass wedge, do not give a straight line law.

A final possibility is to diminish the incident light by a method similar in principle to the Trotter-Waldram daylight device. The observed white test-plate, used with a brightness photometer of the Lumeter type, might be treated in a similar manner to the white sky. One might, for example, introduce into the photometer a tube, having at one end an opal glass and at the other a variable opening such that the area of the illuminated surface subtended at the opal glass might be altered within given limits. This method has one advantage, that a straight line law of diminution could be obtained. But in practice there are inconveniences. Unless the area of the test plate is very large the diminution in illumination brought about by inserting such an accessory apparatus is very great; it is in fact only useful when the diminution required is of the order of 1/100 or 1/1000. Also, owing to the interposition of the opal glass the observer can no longer see the surface being examined; by inadvertently tilting the instrument slightly so that the observed surface no longer covered the reducing aperture, he might therefore easily make very big errors.

These considerations apparently render the method of small practical utility for observing the brightness of illuminated surfaces, except in very special cases. It has, however, merits when candle-power is to be tested and the source and photometer can be fixed at a convenient distance apart. In these circumstances it is possible to bring about in a very small space an almost indefinitely large reduction in illumination, the value of which can be accurately determined by calibration. A device substantially in accordance with this principle was used at the National Physical Laboratory a few years ago in some experiments on the observation of faint lights.

To sum up, it is evident that there are objections to all the devices hitherto proposed for diminishing the light from the source or surface tested in illumination photometers. Research in this direction is needed, for success in meeting the problem might lead to considerable simplifications in the design of such instruments, and to extensions of their present fields of utility.

THE UTILISATION OF IRISH PEAT.

The Fuel Research Board, with the sanction of the Committee of the Privy Council for Scientific and Industrial Research, has appointed a Committee of Inquiry into the utilisation of Irish peat deposits.

The terms of reference to the Committee are as follows:—

"To enquire into and to consider the experience already gained in Ireland in respect of the winning, preparation and use of peat for fuel and for other purposes, and to suggest what means shall be taken to ascertain the conditions under which, in the most favourably situated localities, it can be profitably won, prepared and used, having regard to the economic conditions in Ireland; and to report to the Fuel Research Board."

The following appointments have been made to the Committee:—Sir John Purser Griffith, M.A.I., M.Inst.C.E. (Chairman), Professor Hugh Ryan, M.A., D.Sc., F.I.C., Professor Sydney Young, D.Sc., F.R.S., Mr. George Fletcher (Dept. of Agriculture and Technical Instruction for Ireland), Professor Pierce Purcell, M.A., M.A.I., Assoc.M.Inst.C.E. (Secretary).

All inquiries should be addressed to: The Secretary, The Peat Enquiry Committee, University College, Dublin.

A STANDARD SPECIFICATION FOR GLOW-LAMPS.*

Prepared by the Swiss Union of Electricity Works.

THE specification last issued by the V.S.E. (1909-10) referred mainly to carbon lamps, and contained relatively few conditions applying to metal filament lamps. The development of the latter, and also the introduction of half-watt lamps, has made a new specification applicable to both types of lamps desirable.

In what follows we give a summary of the new specification. Two points deserve special reference :—

(A) In view of the different types of metal filament lamps introduced, having widely different distribution of light, the old ratio between mean horizontal candlepower and mean spherical candlepower (given as 1·2), often no longer applies. This is particularly true of gas-filled lamps. It has accordingly been decided to state illuminating value in mean spherical candlepower in future. In the present specification both mean spherical and mean horizontal values are given for vacuum lamps.

(B) It is now recognised as more convenient for lamps to be graded and marked in watts. This practice, which has become usual in other countries, is now to be adopted in Switzerland, having been agreed to by the chief lamp-makers. For the present year, however, manufacturers will supply lamps marked in candlepower if specially desired to do so.

In the case of carbon filament lamps, for which, as stated above, no new conditions are specified, three different specific consumptions have hitherto been recognised. For metal filament lamps two types are now suggested, designated "A" and "B," having respectively a useful life of 800 and 1,600 hours (*i.e.*, a period of use of 800 and 1,600 hours before the candlepower has fallen by 20 per cent). In the case of gas-filled lamps, only one type, with a useful life of 800 hours, is covered by the specification.

On pp. 194—196 we give a summary of the specification. In order to avoid repetition, it is convenient to deal separately with clauses that refer respectively to vacuum and gas-filled lamps, which are dealt with on adjacent columns, and to arrange matter which is common to both classes, to go right across the page.

At the conclusion of the specification a definition of mean spherical candlepower is given, and it is suggested that the test should be undertaken by means of the Ulbricht Globe, which is briefly described. It is recommended that the globe should be calibrated by observation of a lamp of known mean spherical candlepower. This enables the constant of the globe to be readily determined, and the mean spherical candlepower of a series of lamps to be thus quickly obtained.

* Abstract of Specification prepared by the Glühlampen-Einkaufs-Vereinigung of the Verband Schweiz. Elektrizitätswerke, published in the *Schweiz. Elektrotechnischer Verein Bulletin*, June, 1917.

SPECIFICATION FOR METAL FILAMENT LAMPS.

Vacuum Lamps.

(1) The conditions apply to all consignments of not less than 100 lamps. They are not applicable to lamps of voltages below 100 or above 250, nor to lamps which fall without the standard range of 10, 15, 20, 25, 30, 40, 50, 60, 80, and 100 watts, nor lamps with obscured or coloured bulbs.

(2) Lamps are supplied in two standard types, of high and low specific consumption corresponding to useful lives of 800 and 1,600 hours respectively, and denoted by the letters A and B.

Gas-Filled Lamps.

(1) The conditions apply to all consignments of not less than 25v. lamps. They are not applicable to lamps of voltages under 100 or exceeding 250, nor to lamps which fall without the standard range of 50, 100, 200, 300, 400, 600, 1,000, 2,000, 3,000, and 5,000 watts, nor to lamps with obscured or coloured bulbs.

(2) Lamps are to be supplied with a useful life of at least 800 hours.

(3) Lamps are to be supplied according to their total consumption in watts.

(4) Lamps shall be marked on their bulbs with the following information :—

(A) Name of the maker ; (B) supply pressure, the word " volt " being omitted ; (C) consumption, the word " watt " indicated ; (D) the letters " G.E.V.," and, *at the desire of the purchaser*, (E) the mean spherical candlepower ; and (F) the name of the purchaser.

Lamps which do not comply, or only partially comply, with these conditions will not be accepted for test, and may be rejected by the purchaser.

Type of vacuum lamp to be indicated by the letter " A " or " B."

(5) Lamps must be without defects as regards construction and material, and must be made of clear glass without blemish and of symmetrical form. The mounting of the lamp in the socket must be strictly axial, and the attachment of the connection wires to the socket executed solidly and with acid-free solution.

Sockets of lamps must comply with the forms prescribed by the " S.E.V."

(6) The testing of lamps for consumption and mean spherical candlepower must be done at the supply voltage indicated on lamp.

(7) Lamps must comply with the following requirements as regards consumption and candlepower :—

The consumption of vacuum lamps, as determined by test, must not deviate above or below the marked value by 4 per cent. For lamps under 25 watts the variation must not exceed ± 1 watt.

The mean spherical candlepower, as determined by test, must not deviate by more than 15 per cent. from the data given in the table on the opposite page.

The consumption of gas-filled lamps, as determined by test, must not deviate above or below the marked value by more than 5 per cent.

The value of the mean spherical candlepower, as determined by test, must not deviate by more than ± 15 per cent. from the marked value, whereby the specific consumption in watts per candle (mean spherical Hefner) must not be higher than the values indicated in the table on the opposite page.

CANDLEPOWER OF VACUUM LAMPS.

Consumption. Watts.	Marked Voltage.	Mean sph. C.P. Hefner.*	
		Type A.	Type B.
10	100–139	7·5	5·0
	140–199	7·0	
	200–250	6·5	
15	100–130	12·0	9·0
	140–199	11.5	
	200–250	11·0	
20	100–139	16·5	13·5
	140–199	16·0	12·0
	200–250	15·5	10·0
25	100–139	21·0	17·5
	140–199	20·5	16·5
	200–250	20·0	15·0
30	100–139	25·5	21·5
	140–199	25·0	20·5
	200–250	24·5	19·0
40	100–139	34·5	29·0
	140–199	34·0	28·0
	200–250	33·0	27·0
50	100–139	42·0	36·0
	140–199	42·0	35·0
	200–250	42·0	34·5
60	100–139	51·0	44·0
	140–199	51·0	43·5
	200–250	51·0	43·0
80	100–139	67·0	59·0
	140–199	67·0	58·5
	200–250	67·0	58·0
100	100–139	85·0	76·0
	140–199	85·0	75·0
	200–250	85·0	74·0

GAS-FILLED LAMPS.

Consumption. Watts.	Maximum specific consumption in Watts per Hefner* for 8 voltages of :—	
	100–174 volts.	175–250 volts.
50	1·0	—
100	0·9	1·0
200	0·8	0·9
300	0·7	0·8
400	0·65	0·7
600	—	—
1000 (and over)	0·65	0·65

* [N.B.—*To convert values of candlepower expressed in Hefners into "international" candles, the above results must be multiplied by the factor* 0·9.—ED.]

(8) By the "useful life" is understood the period of continuous burning at the indicated voltage, during which the mean spherical candlepower of the lamps does not diminish by more than 20 per cent. from its initial value; if the lamps fail before this point is attained, the period of burning up to this point is regarded as the useful life.

For life-tests only those lamps which comply with the conditions set forth in (7) should be accepted, and from these the tests should be carried out on those lamps whose consumption and candlepower, at the indicated voltage, approach as close as possible to the prescribed values.

The life-test should be undertaken in the case of vacuum lamps of the type A, on the indicated voltage; in the case of lamps of type B at a higher voltage such that the specific consumption in watts per candle of the group of five lamps of the same kind to be tested (in accordance with (9)) is reduced to that of A lamps of corresponding power.

The life-test on gas-filled lamps should be undertaken at the indicated voltage.

(9) The test of useful life, undertaken on behalf of the purchaser, is to be made on a selection of 5 out of each batch of lamps of the same kind. Lamps which are broken in the process of unpacking and testing are not to be included in results.

The tests of candlepower and consumption are to be made on 10 per cent. of the lamps in each batch submitted. If the number of lamps is less than 150, at least 15 lamps should be tested ; if over 15,000 lamps, at the most 1,500 should be tested. If lamps of different types and sizes are included, tests should be made on 10 per cent. of each type or size ; in the case of batches from 150 to 15,000, they should be selected proportionately out of the 15 and 15,000 respectively set aside for test.

Tests of candlepower and consumption should be made on 5 per cent., but on at least 10 lamps of each power.

(10) A consignment of lamps can be returned :—

(A) If the useful life of more than 40 per cent. of the lamps tested has not reached 800 hours.

(B) Within 30 days after the delivery of the lamps at the testing laboratory of the S.E.V., if more than 20 per cent. of the lamps tested do not comply with one or more of the prescribed conditions in regard to construction, candlepower, or consumption.

If lamps are returned as a result of failure to pass tests of useful life the cost of such life-tests on selected lamps is to be met by the seller of the lamps. In the event of the purchaser having put into use a portion of the consignment, the above condition shall apply to the remainder of the consignment which has not yet been put into use. Lamps which have been subjected to test may be returned, but those that have been put into use cannot.

(11) The place of test prescribed is the Laboratory (Materialprüfanstalt) of the Schweizerischer Elektrotechnischer Verein at Zurich. Lamps for test should be forwarded to this address immediately after the receipt of a consignment by the purchaser.

(12) The Laboratory of the S.E.V. keeps records of the tests to which appeal may be made in case of dispute, and which are accepted both by the seller and purchaser.

The contesting of consignments rests with the purchaser.

RADIATION FROM HELICAL FILAMENTS.

A recent investigation undertaken at the Bureau of Standards by W. Coblentz, deals with the phenomenon that the interior of the helices of filaments in half-watt lamps appears to be considerably brighter than the exterior portions—in some cases nearly twice as bright.

It has been shown that this cannot be due to higher temperature. Pyrometric and other measurements make it clear that the difference in temperature cannot exceed 5 deg., whereas a difference of 200 deg. would be necessary to explain the greater brightness.

Further investigations showed that the light from within the helix is different in quality from that emitted by its outer surfaces. It is highly polarised and also distinctly bluer in tint.

The probable explanation lies in multiple reflection from the adjacent tungsten surfaces. This would have the effect of increasing the brightness and, as polished tungsten may be expected to exercise selective reflection, may also explain the difference in colour.

INSPECTION LAMP FOR MOTORISTS.

In *Popular Mechanics* a useful form of inspection lamp for motorists and others is described. It consists of a small lamp in metal case, fed by flexible leads from a portable battery, and attached by an 18 in. length of flexible tube to a handle. This is very serviceable for the inspection of mechanism which is difficult of access. An additional feature is the use of a magnetised metal case surrounding the lamp which is very convenient for picking up small iron parts.

SHORT NOTES ON ILLUMINATING ENGINEERING.

ILLUMINATING ENGINEERING SOCIETY (U.S.A.)

National Committee on Lighting in the United States.

The Illuminating Engineering Society (U.S.A.) has been given opportunity to co-operate with the Council of National Defence by the appointment of the National Committee on Lighting. This committee was appointed by Mr. Samuel Gompers, Chairman of the Committee on Labour of the Advisory Commission of the Council of National Defence.

The National Committee on Lighting will serve as a Sub-Committee to advise on all matters relating to this subject that come within the scope of the Committee on Labour, including the conservation of health and welfare of workers. This work will deal primarily with the lighting of all factories, mills, industrial establishments and other work places, especially munition plants, government shops, arsenals, and all concerns directly under contract with the Government.

The work of the Committee on Lighting will be directed broadly to the problem of improving lighting conditions with the following objects in mind:—

(*a*) Conservation of the eyesight of workmen.
(*b*) Minimising, accidents.
(*c*) Increasing production.
(*d*) Decreasing spoilage.
(*e*) Protection of property and persons

To assist in accomplishing these ends, the Committee will prepare a specification containing rules for adequate and safe lighting, including data for the minimum and desirable standards of light intensity for different classes of work, and directions for minimising glare. It is planned to supplement these rules by descriptive notes and illustrations that will set forth plainly and definitely the way in which the recommendations of the Committee may be carried out in practice. The National Committee on Lighting has been officially authorised to proceed with this work.

Arrangements for Convention.

In view of the cancelling of the usual Annual Convention, owing to the war, the Society will hold a "Corresponding Convention, the papers being circulated amongst members and written contributions to the discussion invited.

Titles and authors of papers will be published in advance in the *Transactions*, and any who are interested can obtain copies upon application to the General Offices of the Society, 29, West 39th Street, New York, U.S.A.

An Illumination Index.

The Committee on Progress is arranging to compile, at regular intervals, an index of important articles dealing with illumination, arranged in chronological order.

In future this index will appear in each issue of the *Transactions*.

Lecture on Shop-Lighting.

A popular lecture on "Store-Lighting," prepared by the Committee on Popular Lectures, is now ready for distribution. It is expected that a similar lecture on "Home-Lighting" will be available shortly.

School Lighting.

Mr. L. B. Marks, the Chairman of the Committee on Lighting Legislation, reports that progress has been made with the preparation of a "Code on School Lighting," which will eventually be made available to the general public.

A JAPANESE ILLUMINATING ENGINEERING SOCIETY.

Readers will be interested to learn that an Illuminating Engineering Society has recently been formed in Japan.

We hope shortly to give fuller particulars of this new offshoot of the illuminating engineering movement. Meantime we wish it every success.

WHITEWASH AS AN AID TO CLEANLINESS.

In *Popular Mechanics* an interesting illustration of the value of light as an aid to cleanliness is mentioned. In a certain Boston factory workers had acquired the insanitary habit of spitting in corners. By the simple expedient of painting the corners with whitewash the habit was checked. The whitewash acted as a reminder and presumably its clean surface, on which stains were readily visible, had a useful suggestive influence.

The janitor, whose duty it was to attend to the sweeping out of corners, was also beneficially affected and, after the whitewash had been applied, carried out his duties with greater care than hitherto. It would probably often be found that in store-rooms, where rubbish tends to accumulate, the simple expedient of whitewashing, by improving the illumination, would promote tidiness.

ILLUMINATION IN WAR TIME—IN THIS COUNTRY AND IN THE UNITED STATES.

In a recent issue of *Electricity* a curious difference in the practice in regard to street lighting in war time in this country and in the United States is noted.

The general tendency here is to reduce illumination to a minimum, whereas in America we hear of *extra* war-lighting, —important yards, bridges, &c., being strongly illuminated. The explanation is interesting. In this country the chief consideration is precaution against hostile aircraft, while under the vigilant action of the police any danger from alien enemies normally resident in the chief cities has been practically suppressed.

In the United States, on the other hand, the danger from air-raids does not exist, but in view of the very large mixed population the possibility of damage by enemy aliens requires consideration. Accordingly, the intention is to flood all important areas with light so as to render the task of any lurking malefactor as difficult as possible.

As our contemporary remarks, it may be impracticable for us to adopt this safety precaution in England, but the lesson is one that will well repay consideration when we return to normal conditions.

LIABILITY FOR STREET ACCIDENTS DUE TO INSUFFICIENT LIGHTING.

The *Gas World* (July 14th, 1917) records a case in the Court of Appeal on July 5th of considerable interest to illuminating engineers.

On a night in April, 1916, Mr. Thos. Morrison, of Leeds, was crossing the street, and on reaching the far side of the road he came into contact with one of the iron spikes fencing a tree, with the result that the sight of one of his eyes was practically destroyed. He therefore sued the Corporation of Sheffield for personal injuries sustained through the decreased street lighting, and at the Leeds Assizes was awarded £660 10s. damages, the Jury finding that the guard was dangerous in the circumstances of the darkness that existed, and that the Corporation ought to have taken reasonable measures to have neutralised the danger. The Corporation now appealed against this decision, relying upon the Defence of the Realm Act, and their right to plant trees in the streets under the Public Health Amendment Act of 1890.

The Court dismissed the appeal. The Lord Justice said that there was an obligation on the defendants to use reasonable care for the whole time during which they maintained the guard to the trees, and they were not entitled to allow them to become dangerous to those who used the highway.

SUBMARINE CRAFT WITHOUT PERISCOPES.

According to an article in the *Revista Marittima*, quoted in the journal of the Royal Society of Arts for July 12th, U boats have now been constructed without periscopes. The arrangement substituted, which appears to be in the experimental stage, consists of two lenses, one on either side of the vessel, which are used in conjunction with other lenses and mirrors. If necessary these lenses and mirrors can also be utilised to project a beam of light outwards from the vessel. The drawback to the device is that the vessel has to be navigated nearer the surface, but it is thought that this is outweighed by the advantage that the arrangement is less visible from a distance.

INVISIBLE SUBMARINES.

It is well known that submarines when below the water can often be located by inspection from a height above. Aeroplanes, for example, are used to locate submarines in this way.

A recent article by H. Woodhouse in *Flying*, summarised in the Franklin Institute for June, mentions that exhaustive experiments have been made with a view to painting submarines in such colours as to render them indistinguishable from the water in which they lie. A limitation to this method is imposed by the fact that submarines have often to traverse large distances, and it is therefore difficult to devise a coloration which will blend with the varied conditions in which they are moving; small boats for coasting purposes, which always operate in similar conditions, are more easily treated in this way.

Another point of some importance is the painting of friendly submarines so as to be clearly distinguishable from hostile ones. If distinctive marks are adopted there is always the danger of their being copied by the enemy, and it is possible that some enemy boats may escape owing to uncertainty as to identity.

LIGHTING AT THE PANAMA-PACIFIC EXHIBITION.

The *Proceedings* of the American Institute of Electrical Engineers for June contains a very complete and interesting account of the special lighting of the above exhibition, by W. D'a Ryan. In addition to detailed diagrams and sketches showing the types of fixtures and their location to meet various lighting problems, the contribution is assisted by a most effective series of colour-prints showing the actual appearance of sections of the exhibition by night. Considerable pains were evidently taken to blend the colours of the courts and exteriors of buildings with the hues of illuminants, and the effective use of concealed lighting produced some wonderful effects.

BRITISH SCIENCE GUILD.

ELEVENTH ANNUAL REPORT OF THE EXECUTIVE COMMITTEE (JUNE, 1917).

In our April issue we gave an account of the proceedings at the last Annual Meeting of the Guild, when addresses were delivered by the Rt. Hon. H. A. L. Fisher, Lord Sydenham, and Mr. H. G. Wells.

In the bulletin now issued a complete account of the annual meeting is given, and the Annual Report gives a valuable summary of recent progress in the promotion of scientific and industrial research. The Appendices, which include a contribution by Professor Barker on the Metric System and the Textile Industries, and notes on Endowment of Education and Research and National Instruction in Technical Optics, are also of considerable interest.

PRODUCTION OF GAS IN THE UNITED STATES.

It is common knowledge that the output of gas in this country has increased enormously since the outbreak of war, and some striking figures on this point were presented in the lecture by Mr. H. M. Thornton before the Royal Society of Arts on April 18th.*

We notice that in a Report of the U.S. Geological Survey Mr- C. E. Lesher gives some useful information relating to the development of gas production in the United States.†

From 1908 to 1915 the output of coal-gas for all purposes has increased from about 150 thousand million cubic feet to about 180 thousand million. The consumption *per capita* of population has risen from 1,417 to 1,809 cub. ft. in the same period. In many respects the year 1908 seems to have been a turning-point in the history of the American gas industry. Equally striking has been the progressive reduction in price simultaneous with the increase in production.

The very marked increase since 1908 seems to be due largely to the greater utilisation of gas for fuel. Another interesting point is the development of oil and other special varieties of gas, bringing the total consumption up to about 270 thousand million cub. ft.

CAMPAIGN TO SECURE MORE GAS LIGHTING BUSINESS.

The National Commercial Gas Association in Canada is showing great activity in regard to lighting. The Illumination Committee has recently addressed to a large number of cities a series of inquiries on the subject, the following queries being included :—

"Will you procure and send to this office the following :—

"Photographs of gas lighting installations (residential, commercial, and factory).

"Number of and types of lamps in each installation.

"Total hourly consumption of lamps in each installation.

"Do you conduct special lighting campaigns ?

"Are you endeavouring to hold your present and secure new gas lighting ?

"What kind of gas lighting literature can you use for general distribution ?

"Are your display windows and showrooms lighted at night ? Kindly send us photographs of each."

An inquiry is also being instituted on the best methods of getting in touch with architects in all the leading cities.

GAS-RIPENED BANANAS.

The *Co-partnership Journal* for May contains a number of interesting notes, including an account of some experiments to ripen bananas by the heat from gas at Idaho, in the Rocky Mountains.

The bananas are hung from rafters in air-tight rooms, each about thirty feet square and six feet high. Gas hot-plates are placed on the floor and heat wash-tubs filled with water, the vapour from which maintains the air of the room at 65—70° Fahr.

The bananas speedily ripen in these circumstances, and the treatment should promote the storage of this useful food.

---

* *Illum. Eng.*, April, 1917, p. 126.

† *Gas Age*, April, 16th, 1917.

TOPICAL AND INDUSTRIAL SECTION.

[At the request of many of our readers we have extended the space devoted to this Section, and are open to receive for publication particulars of interesting installations, new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]

SHOP-WINDOW LIGHTING BY CONCEALED LIGHTS.

Even before the war the wastefulness of lighting shop windows by a series of flame arc lamps or other high-power illuminants placed slightly above the eye-level of people in the streets was well recognised by experts in illumination. In the present circumstances such methods are particularly undesirable, as they are responsible indirectly for waste of coal, besides being a great eye-sore in the present darkened condition of the streets.

Shopkeepers have therefore every inducement to practise the concealed method of lighting, throwing the rays of light on the goods, and emitting little or no light on the roadway.

In ordinary circumstances a window may sometimes be lighted by weather-proof lanterns containing half-watt lamps, the reflectors being so shaped as to reflect the light into the window but shield it from the eyes of passers-by. The method may be used in flat windows and in cases where there are no successive lines of goods such as would cast inconvenient shadows. But it is comparatively seldom that this method can be employed.

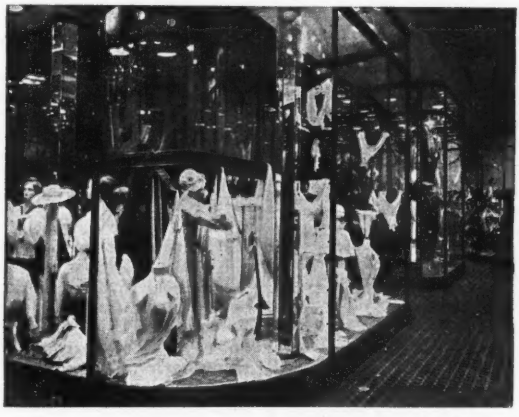


FIG. 1.—Showing concealed lighting of window with half-watt lamps and X-ray reflectors.

In the accompanying illustration, for which we are indebted to the British Thomson Houston Co., Ltd., the lighting is carried out with Mazda "half-watt" lamps and X-ray reflectors placed inside the window but well above the line of vision. In these circumstances we get the effect of light on the goods, without the filaments being visible to people outside the shop.

REVIEW OF BOOK.

Health of Munition Workers' Committee, Memorandum No. 18 : "Further statistical information concerning output in relation to Hours of Work, with special reference to the influence of Sunday Labour." By H. M. Vernon, M.D.

THIS bulletin is supplementary to Memorandum No. 5 on "Hours of Work." Dr. Vernon's further researches confirm conclusively the views tentatively suggested regarding the prejudicial effect of excessive hours and Sunday labour. Groups of workers have been kept under observation for long periods and their daily and weekly variations in output analysed. In the case of 100 women kept under observation for more than a year, it is shown clearly that a reduction in hours of work and the enforcement of a rest on Sunday has, so far from diminishing output, actually increased it, and a similar result is recorded for 56 men engaged in heavy labour.

The whole question is studied in a most thorough and scientific way. The cumulative influence of fatigue during the week can be clearly traced by diagrams, and the benefit of the pause for recuperation on Sunday is manifest.

One incidental point of great interest is the study of possible limitation of output. By an ingenious method based on the laws of probability, Dr. Vernon is able to confirm his contention that there were no trade union restrictions on the output of workers. The method applied may suggest a useful test in other cases.

Assets exceed £2,500,000.

Claims paid over £8,500,000.

By Appointment.

GENERAL

Accident Fire and Life

ASSURANCE CORPORATION, Ltd.

General Buildings, Perth, Scotland.
General Buildings, Aldwych, London.

Established 1885.

WAR ECONOMY.

In consequence of the War, the cost of building material and labour has increased nearly 50 per cent. All owners of property should therefore increase their Fire Insurances ; this they can do at little or no extra cost by taking a Fire Bonus Policy with this Corporation, and thus effect a saving of 20 per cent. of each premium.

Particulars on receipt of post card at either of the above Offices.

F. NORIE-MILLER, J.P
General Manager.

PERSONAL.

Mr. A. P. Trotter, after 21 years Government service, is returning to professional practice as a Consulting Engineer and is joining Messrs. Handcock and Dykes, as partner in the firm of Handcock, Dykes and Trotter, at 11, Victoria Street, London, S.W.1.

Mr. Trotter is B.A. of Cambridge, Member of the Institution of Civil Engineers, Member of the Institution of Mechanical Engineers, Member of Council of the Institution of Electrical Engineers, President of the Illuminating Engineering Society, Vice-Chairman of the National Illumination Commission of Great Britain (affiliated to the International Illumination Commission), Chairman of the Joint Committee on Illuminating Engineering of the Department of Scientific and Industrial Research, and member of other scientific institutions.

In 1896 he took up the post of Electrical Engineer to the Government of the Cape of Good Hope, and in 1899 he returned to London, since when he has been electrical adviser to the Board of Trade

Readers of this journal will join us in wishing Mr. Trotter every success in his new work.

INDEX, July, 1917.

	PAGE
Automobile Headlights	183
Conjoint Board of Scientific Societies, Report of	184
Editorial. L. GASTER	179
Helical Filaments, Radiation from	196
Industrial Lighting, Notes on. By C. E. CLEWELL	185
Irish Peat, Utilisation of	192
National Physical Laboratory, Report	184
Neutral Tinted Glass and other Methods of Diminishing Incident Light in Illumination Photometry By AN ENGINEERING CORRESPONDENT	190
Personal Notes	202
Production of Gas in the United States	200
REVIEWS OF BOOKS :— Industrial Fatigue. By H. M. VERNON.	
SHORT NOTES ON ILLUMINATING ENGINEERING :— A National Committee on Lighting (U.S.A.)—A Japanese Illuminating Engineering Society—Whitewash as an Aid to Cleanliness—Illumination in War Time—Liability for Street Accidents due to Insufficient Lighting—Submarine Craft Without Periscopes—Invisible Submarines—Lighting at the Panama-Pacific Exhibition—British Science Guild.	197
Standard Specification for Metal Filament Lamps, A	193
Theatre Lights in the Past	189
TOPICAL AND INDUSTRIAL SECTION :— Show-Window Lighting by Concealed Lights—Simplex Anti-Zeppelin Reflectors.	201

COUPON INSURANCE TICKET

Applicable only within the United Kingdom.

GENERAL

ACCIDENT FIRE AND LIFE

ASSURANCE CORPORATION, LTD.,

Chief Offices—

GENERAL BUILDINGS, PERTH, SCOTLAND.
GENERAL BUILDINGS, ALDWYCH, LONDON, W.C.
F. NORIE-MILLER, J.P., General Manager.

To whom Notice of Claims under the following conditions must be sent within seven days of accident.

£250 TWO HUNDRED AND FIFTY POUNDS will be paid by the above Corporation to the legal personal representatives of any person who is killed by an accident causing material damage to the passenger train in which the deceased was travelling as a ticket bearing or paying passenger, or who shall have been fatally injured thereby, should death result within one calendar month after such accident. **Provided** that the person so killed or injured had upon his or her person, or had left at home this coupon, with his or her usual signature, written prior to the accident, in the space provided below, which, together with the giving of notice within seven days to the above Corporation is the essence of this contract.

This Insurance only applies to persons over 14 and under 65 years of age, is subject to the conditions stated above and contained in the General Accident Fire and Life Assurance Corporation Act, 1907, and holds good for the current month of issue only.

No person can recover under more than one Coupon Ticket in respect of the same risk.

Signature .....

This Coupon must not be cut out but left intact in THE ILLUMINATING ENGINEER as that being dated, forms the only evidence of its currency.

SIMPLEX ANTI-ZEPPELIN REFLECTORS.

Some recent lists issued by Messrs. Simplex Conduits, Ltd., show a variety of metal reflectors that are stated to be particularly well adapted to conditions of industrial lighting at the present time. Of special interest are the "Anti-Zeppelin" reflectors, an example of which is shown in Fig. 1. This variety is intended for half-watt lamps, and is of the "intensive" type; a corresponding "extensive" type, intended to give a wider distribution of light, is also made.

These reflectors are particularly suitable for lighting factories with much window space or roof-lighting. The Lighting Regulations forbid the exhibition of unscreened lights in such cases. With this type of reflector the lamp is completely hidden, and they have also the advantage from an illuminating engineering standpoint of avoiding glare and directing the light where it is chiefly wanted—on the work being executed

It would be useful also to have the polar curves of light-distribution of these units, and we would suggest that these should be shown in the next edition of these lists.

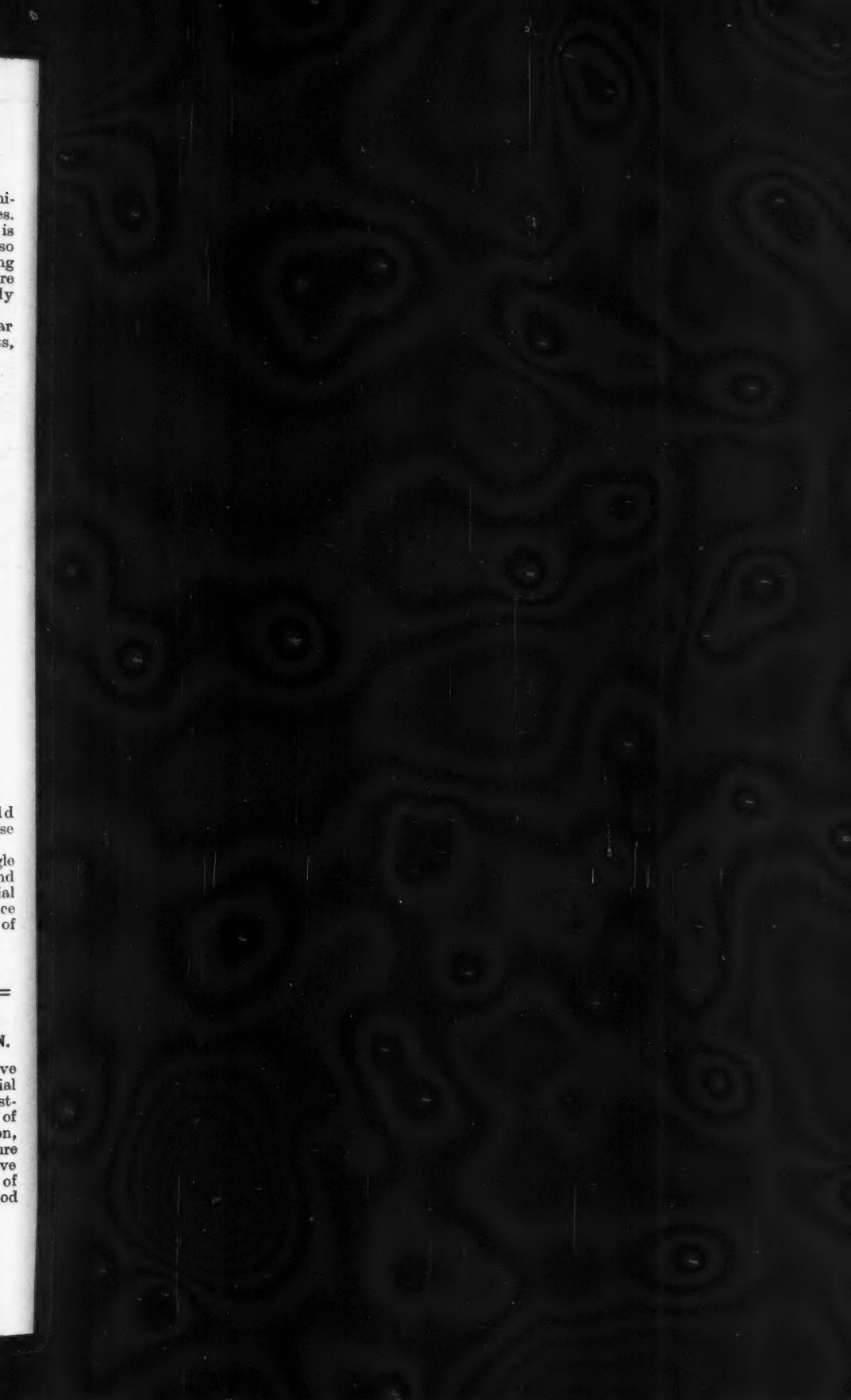
FIG. 1.—Simplex "Anti-Zeppelin" Reflector. (Intensive type for half-watt lamps.)

FIG. 2.—Simplex Angle Reflector for half-watt lamps.

The other illustration shows an Angle Reflector, also for half-watt lamps and intended for the illumination of special local positions, or where the interference of girders or belting makes the use of ordinary reflectors impracticable.

EDISWAN PICTURE-LIGHTING-FITTING.

A form of picture lighting fitting has been introduced by the Edison and Swan United Electric Light Co., Ltd., which is claimed to have special advantages for lighting flat surfaces, and for desks, pulpits, and orchestra lighting. We understand that the fitting was employed for lighting the Choir Stalls in Westminster Abbey.

COAL GAS FOR MOTOR TRACTION.

A report issued by the Executive Committee of the British Commercial Gas Association contains much interesting information on the utilisation of compressed coal gas for motor traction, which is stored in cylinders at a pressure of 20—25 atmospheres. Trial runs have given promising results, and in view of the present shortage of petrol the method has considerable possibilities.